

Abstract Title Page
Not included in page count.

Title:

Testing the Efficacy of a Kindergarten Tier 2 Intervention Program

Author(s):

Ben Clarke, PhD (University of Oregon)
Scott K. Baker, PhD (University of Oregon)
Keith Smolkowski, PhD (Oregon Research Institute)
Hank Fien, PhD (University of Oregon)
Chris Doabler, PhD (University of Oregon)
Mari Strand Cary PhD (University of Oregon)
David Chard, PhD (Southern Methodist University)

Abstract Body

Limit 4 pages single spaced.

Background / Context:

Description of prior research and its intellectual context.

For many years, educators have been concerned about the low level of mathematics performance of U.S. students in relation to national standards and in international comparisons (National Research Council, 2001). Difficulties in mathematics achievement are particularly severe for students from low income and minority backgrounds (National Assessment of Educational Progress, 2007) and warning signs of problems appear early. Significant differences between subpopulations of students can be reliably measured at school entry on measures related to counting principles and number knowledge to more complex understandings of quantities, operations, and problem solving (Griffin, Case, & Siegler, 1994; Jordan, Kaplan, Olah, & Locuniak, 2006). A number of studies (Bodovski & Farkas, 2007; Duncan et al., 2007; Morgan, Farkas, & Wu, 2009) have documented the relationship between early and later math achievement (e.g., kindergarten to fourth grade). Using a nationally representative sample of students from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K), Morgan et al. (2009) found that students who were in the lowest 10th percentile at both the beginning and end of kindergarten had a 70% chance of remaining in the lowest 10th percentile five years later. One promising approach to improving kindergarten and later math achievement is delivering effective instructional programs to all students when they enter school to bridge the emerging achievement gap and promote early mathematics learning.

Effective instructional and intervention programs for the full range of students in classrooms—from students who are on track for successful learning outcomes to students who are experiencing difficulty and need additional service and support—is the basis of a Response to Intervention (RTI) service delivery model. RTI is an integrated approach that spans general, remedial, and special education (Fuchs, Fuchs, & Compton, 2004). RtI emphasizes high quality instruction in general education, interventions for at-risk students that are matched to instructional need, and the use of data to document student responsiveness to instruction and intervention for the purpose of making ongoing educational and instructional decisions (Batsche et al., 2005). Although variations to RtI models exist (Gersten et al., 2009; NASDSE, 2006) most tiered models have 3 levels of support with Tier 1 consisting of the instruction delivered in general education by the classroom teacher. Tier 2 is targeted instruction delivered in small groups to at-risk students and Tier 3 is provided to students who have not responded to Tier 2 small group interventions. Tier 3 typically consists of highly intense interventions including one-on-one tutoring.

The purpose of this study, funded by the *Institute for Education Sciences* under the *Mathematics and Science Education* topic, was to test the efficacy of a Tier 2 intervention curriculum, *ROOTS*, when implemented under rigorous experimental conditions. In this study all classrooms implemented a validated Tier 1 core curriculum (Clarke et al., in press), and classrooms were randomly assigned to treatment and comparison conditions, blocking on school. Treatment classrooms implemented the validated Tier 1 core curriculum plus the *ROOTS* an intervention program for at-risk students. Comparison classrooms implemented the validated Tier 1 core curriculum plus standard district practice for intervening with at-risk students.

The validated Tier 1 curriculum used by all classrooms was the Early Learning in

Mathematics curriculum (ELM). As part of IES funding for this project, in a previous study (Study 1) ELM was tested in a randomized controlled trial, with treatment classroom implementing ELM as their Tier 1 mathematics curriculum and comparison classrooms implementing the district's standard mathematics curriculum for Tier 1 (Clarke, Smolkowski, Baker, Fien, & Chard, in press). ELM had a statistically significant impact on the mathematics achievement of kindergarten students overall ($p = .03$; Hedges' $g = 0.14$) and it was particularly beneficial for at-risk students ($p < .01$; $g = 0.24$), although at-risk students did not catch up to their average-achieving peers by the end of the study (Clarke et al., in press). The content of the year-long ELM curriculum focuses on (a) whole number and operations; (b) measurement; (c) geometry; and (d) precise mathematics vocabulary.

Purpose / Objective / Research Question / Focus of Study:

Description of the focus of the research.

This presentation will address our primary intervention research question for Study 2: For at-risk students, what is the impact on mathematics achievement of the ROOTS intervention delivered in conjunction with an effective core curriculum (ELM) compared to an effective core curriculum (ELM) and standard district practice for intervening with at-risk students? This comparison holds constant the core curriculum, allowing us to focus of the intervention with at-risk students. We expect that classrooms that implement ELM plus ROOTS for at-risk students will have higher proximal and distal achievement scores than classrooms that implement ELM plus standard district intervention practice for at-risk students.

Setting:

Description of the research location.

Study 2 was conducted in Oregon during the 2009-2010 school year. The study took place in twelve schools in three medium sized (12,062-20,714) suburban school districts located in the northwest. The school districts had similar demographics with a median of 12.2% receiving special education services, 11.2% are English language learners, and 44.9% are eligible for free/reduced lunch. A total of 29 kindergarten classrooms were randomly assigned to treatment and comparison conditions. The amount of time mathematics instruction was provided each day for at-risk students was the same in treatment and comparison classrooms.

Population / Participants / Subjects:

Description of the participants in the study: who, how many, key features, or characteristics.

The study sample included two participant groups: kindergarten instructional assistants and at-risk students in the participating kindergarten classrooms. The instructional assistant sample included 29 different instructional assistants. The student sample included 143 students. To be eligible for ROOTS, student had to meet two criteria. First, they had to score below the 40th percentile on the TEMA at pre-test. Second, teachers were provided a list of all students in their classroom that met the TEMA criteria. Teachers then nominated five students to receive ROOTS who they believed would most benefit from a Tier 2 intervention. In comparison classrooms all students were pretested on the TEMA and teachers identified the students below the 40th percentile on the TEMA who they believed would benefit most from a Tier 2 intervention

Intervention / Program / Practice:

*Description of the intervention, program, or practice, including details of administration and duration.
For Track 2, this may include the development and validation of a measurement instrument.*

ROOTS is a 50-lesson Tier 2 intervention program designed for students who are not responding to validated Tier 1 instruction. Instructional assistants (IAs) implement ROOTS, teaching two to three lessons per week, for approximately 20 weeks.

ROOTS was designed according to instructional design principles shown to effective for at-risk students (Gersten et al., 2009; National Mathematics Advisory Panel, 2008). ROOTS focuses exclusively on the development of whole number understanding. Specific focus areas are developing proficiency in numeration to 20, counting, identifying and writing numbers to 20, counting from a number other than 1, reading and solving simple addition statements, understanding place value and model numbers to 20, and identifying quantities and numbers that are more, less, and equal.

Research Design:

Description of the research design.

Study 2 evaluated ROOTS within a cluster-randomized controlled trial (Murray, 1998, 2001). The study nested students within classrooms and classrooms nested within conditions, and classrooms were randomly assigned to condition within schools. Math achievement data were collected from individual students, and random assignment and instructional delivery took place at the classroom level. Project staff tested students on math achievement at the beginning (T_1) and end (T_2) of the students' kindergarten school year with the Test of Early Mathematics Ability-Third Edition (Ginsburg & Baroody, 1990) and a set of early numeracy curriculum-based measures (Clarke, Baker, Smolkowski, & Chard, 2008).

Data Collection and Analysis:

*Description of the methods for collecting and analyzing data.
For Track 2, this may include the use of existing datasets.*

Trained staff members collected all student and classroom observation data after meeting reliability standards for each measure. The primary outcome was performance on the TEMA-3. The TEMA-3 is a norm-referenced individually administered measure of early mathematics for children ages 3 to 8 years 11 months. The TEMA-3 measures both formal and informal mathematics including skills related to counting, number facts and calculations, and related mathematical concepts. The alternate-form reliability of the TEMA-3 is reported as .97 and test-retest reliability ranges are reported to be from .82 to .93. Concurrent validity with other criterion measures of mathematics is reported as ranging from .54 to .91. Secondary outcome measures were Early Numeracy-Curriculum-Based Measures (EN-CBM) (Clarke & Shinn, 2004). EN-CBM are a set of measures based on principles of curriculum-based measurement (Shinn, 1989). Each 1-minute fluency-based measure assesses an important aspect of early numeracy development including oral counting, magnitude comparison and strategic counting. Concurrent and predictive validity range from .46 to .72 with other published standardized measures.

We assessed intervention effects on each of the primary outcomes with a nested time by condition analysis (Murray, 1998). This analysis approach tests differences between conditions

on change in outcomes from the beginning of kindergarten (T_1) to the end of kindergarten (T_2). This analysis approach included all data—whether or not a student’s scores were present at both time points—to estimate differences between assessments times and between conditions. It also accounts for autocorrelation among assessments within individual students and the intraclass correlation associated with multiple students nested within the same schools. As a test of net differences, it provides a straightforward interpretation of the results.

We computed an effect size, Hedges’ g (Hedges, 1981), for each fixed effects. Hedges’ g represents an individual-level effect size comparable to Cohen’s d (Rosenthal, Rosnow, & Rubin, 2000); Cohen’s d uses a sample standard deviation and Hedges’ g uses a population standard deviation (Rosenthal & Rosnow, 2008). Hedges’ g is recommended by the What Works Clearinghouse (2008) for multilevel models and characterizes the *total* effect, which ignores clustering. It tends to be more conservative than other effect size indicators.

Findings / Results:

Description of the main findings with specific details.

The results of the analyses suggest that at-risk students may have performed better in classrooms that provided ROOTS than in classrooms that offered standard district practice. We found small to medium effect sizes for the TEMA ($g = 0.32$), CBM total ($g = 0.31$), and one individual CBM measure, Quantity Discrimination ($g = 0.50$). All effect sizes meet the WWC standards (What Works Clearinghouse, 2008) for showing a “substantively important positive effect” (p. 54). Although the effect sizes were encouraging, we were unable to reject the null hypothesis for the TEMA ($p = .066$) or CBM total ($p = .144$). For Quantity Discrimination, however, we found a statistically significant result ($p = .011$). All tests used 27 degrees of freedom corresponding to the classroom level.

Conclusions:

Description of conclusions, recommendations, and limitations based on findings.

This presentation will cover the findings of a cluster-randomized controlled evaluation of the ROOTS Tier 2 intervention. ROOTS was implemented within the context of an empirically validated core curriculum. We will address the issue of having sufficient power in this study to detect statistically significant effects and we will describe how a second wave of data will be collected to improve overall power for Study 2. We will discuss possible implications of our findings in the context of response to intervention (RTI) service delivery models. The findings from this study will be used to illustrate how research-based curricula can be used at multiple tiers to address the learning needs of at-risk students and reduce the achievement gap between at-risk students and their average-achieving peers.

Appendices

Not included in page count.

Appendix A. References

References are to be in APA version 6 format.

References

- Batsche, G., Elliott, J., Graden, J., Grimes, J., Kovaleski, J., Prasse, D., . . . Tilly III, W. D. (2005). IDEA'04. Response to intervention: Policy considerations and implementation. Alexandria, VA National Association of State Directors of Special Education (U.S.).
- Bodovski, K., & Farkas, G. (2007). Do instructional practices contribute to inequality in achievement? The case of mathematics instruction in kindergarten. *Journal of Early Childhood Research*, 5, 301–322.
- Clarke, B., Baker, S. K., Smolkowski, K., & Chard, D. J. J. (2008). An analysis of early numeracy curriculum-based measurement. *Remedial and Special Education*, 29(1), 46–57. doi: 10.1177/0741932507309694
- Clarke, B., & Shinn, M. R. (2004). A preliminary investigation into the identification and development of early mathematics curriculum-based measurement. *School Psychology Review*, 33, 234–248.
- Clarke, B., Smolkowski, K., Baker, S. K., Fien, H., & Chard, D. (in press). The impact of a comprehensive tier 1 kindergarten curriculum on the achievement of students at-risk in mathematics. *Elementary School Journal*.
- Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., . . . Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, 43(6), 1428–1446. doi: 10.1037/0012-1649.43.6.1428
- Fuchs, D., Fuchs, L. S., & Compton, D. L. (2004). Identifying reading disabilities by responsiveness-to-instruction: Specifying measures and criteria. *Learning Disability Quarterly*, 27(4), 216.
- Gersten, R., Beckmann, S., Clarke, B., Foegen, A., March, L., Star, J. R., & Witzel, B. (2009). Assisting students struggling with mathematics: Response to Intervention (RtI) for elementary and middle schools. (Practice Guide Report). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, US Department of Education.
- Ginsburg, H. P., & Baroody, A. J. (1990). *Test of early mathematics ability- Third edition (TEMA-3)*. Austin, TX: ProEd.
- Griffin, S., Case, R., & Siegler, R. S. (1994). Rightstart: Providing the central conceptual prerequisites for first learning of arithmetic to students at risk for school failure. In K. McGilly (Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice* (pp. 24–49). Cambridge, MA: MIT Press.
- Jordan, N., Kaplan, D., Olah, L., & Locuniak, M. (2006). Number sense growth in kindergarten: A longitudinal investigation of children at-risk for mathematics difficulties. *Child Development*, 77(1), 153–177.
- Morgan, P. L., Farkas, G., & Wu, Q. (2009). Five-year growth trajectories of kindergarten children with learning difficulties in mathematics. *Journal of Learning Disabilities*, 42(4), 306–321.

- Murray, D. M. (1998). *Design and analysis of group-randomized trials*. New York: Oxford University Press.
- Murray, D. M. (2001). Statistical model appropriate for designs often used in group-randomized trials. *Statistics in Medicine*, 20, 1373–1385.
- NASDSE. (2006). *Response to intervention. A joint paper by the National Association of State Directors of Special Education and the Council of Administrators of Special Education*. .
- National Assessment of Educational Progress. (2007). *Nation's Report Card: Mathematics 2007*. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, US Department of Education.
- National Center for Education Sciences. (nd). Early Childhood Longitudinal Study, Kindergarten Class of 1998-99. from <http://nces.ed.gov/ecls/kindergarten.asp>
- National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel*. Washington, DC: US Department of Education.
- National Research Council. (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: Mathematics Learning Study Committee.
- Shinn, M. R. (1989). *Curriculum-based measurement: Assessing special children*. New York: Guilford.
- What Works Clearinghouse. (2008). *What Works Clearinghouse: Procedures and standards handbook (Version 2.0)*. Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, US Department of Education.

Appendix B. Tables and Figures

Not included in page count.